

# A Proposal Of a Novel Experiment To Measure One Way Speed Of Light

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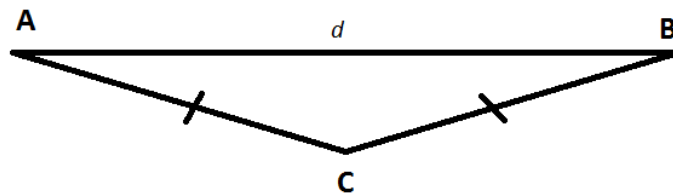
## ABSTRACT

This paper tries to propose a novel experiment to measure the one way speed of light between two points, by exploiting the possibility of using objects, to communicate, which are moving at comparatively low speed than light, thereby avoiding relativistic effects and possibility of difference in light's speed in various directions affecting the outcome of the experiment.

## EXPERIMENT

SETUP: Let's say there are two points A and B and we want to measure the speed of light from A to B and the distance between A and B is  $d$ . So we station our apparatus which can send a light signal on A and another one, which can receive a light signal on B. A and B is equipped with identical apparatus which can shoot a ball. There is another point C which is equidistant from both A and B. C is equipped to measure the time interval between the consecutive arrival of balls from A and B. Both A and B shoots the balls at same speed if the speed of light is same in all directions, and they shoot the balls at nearly same speed even if light travels in different speed in different directions, but the difference in speed of the balls launched, introduced by special relativity is very small to affect the results of the experiment in a meaningful way. Refer NUMERICAL EXAMPLE section.

Note: There are no clocks on either A or B. The points A, B and C are in rest with respect to each other.



Now, A shoots ball-A towards C and simultaneously sends a light signal to B, and the moment B receives the light signal from A, B shoots ball-B towards C. Now both balls ball-A and ball-B head towards C and reach C. The time difference  $\Delta t$ , between the arrival of ball-A and ball-B is expected to be same as the time taken for light to travel from A to B.

$$c_{AB} = \Delta t / d$$

There are no relativistic effects involved as the balls are travelling at relatively small speed than light. And A, B and C are all at rest with respect to each other. By using balls, to signal to a third point C,

instead of B using light to try to communicate back with A, this experimental setup solves the need to synchronize clocks between A and B and also avoids the circular trip of light.

### NUMERICAL EXAMPLE

One of the immediate questions raised here is, well there are no two clocks so there is no synchronization needed, also A, B and C are in rest with respect to each other so there are all measuring everything the same way, **BUT** the balls are shot in opposite directions, so the speeds of the balls could be different just as much to make the measurement of the experiment again same as  $c$ , even though light travels at infinite speed in one direction. Which is not true as the **difference introduced by special relativity is very small to affect the results of the experiment in a meaningful way**. This is shown in the following numerical example.

Consider this,

1. Let AB be 299,792,458 m
2. CA and CB be 200,000,000 m
3. And the ball from A and B be launched by spending 0.5 MJ of energy and both the balls weigh 1 kg.

So if light travels instantaneously from A to B, then both ball<sub>A</sub> and ball<sub>B</sub> start at the same time, but for C to measure the speed of light from A to B be as  $c$ , ball<sub>B</sub> must reach C one second after ball<sub>A</sub> reaches C. If ball<sub>A</sub> is launched from A using 0.5 MJ, it will travel at 1000 m/s and cover the distance of CA in 200,000 seconds.  **$V_a = 1000 \text{ m/s}$** . B, despite starting at the same time must reach in 200,001 seconds. That means the speed of ball<sub>B</sub> should be

$$V_b = 200,000,000 \text{ m} / 200,001 \text{ s} = 999.995000025 \text{ m/s}$$

Only then C measures the speed of light from A to B as  $c$ . But there is no reason why ball<sub>B</sub> would reach this velocity. The only reason why ball<sub>B</sub> can be slower is because it may be travelling in a direction, in which light travels at  $c/2$ . But if we apply relativistic velocity to ball<sub>B</sub>, the effects won't slow down ball<sub>B</sub> so as to create a delay of one second. Relativistic speed of ball<sub>A</sub> would be still 1000m/s as it is travelling in the direction in which light propagates at infinite speed.

Relativistic velocity of ball<sub>B</sub> travelling in the direction in which light propagates at  $c/2$ , is

$$v = \frac{c}{2} \sqrt{1 - \frac{1}{\left(1 + \frac{K_e}{m(\frac{c}{2})^2}\right)^2}}$$

$$149896229 \sqrt{1 - \frac{1}{\left(1 + \frac{500000}{(149896229)^2}\right)^2}} = 999.99999998$$

So the relativistic velocity of ball<sub>B</sub> would be 999.99999998 m/s. So the time taken by ball<sub>B</sub> to travel from B to C would be

$$t_b = 200,000,000 \text{ m} / 999.99999998 \text{ m/s}$$
$$t_b = 200000.000004 \text{ s}$$

So the difference between the arrival of ball<sub>A</sub> and ball<sub>B</sub> is  $t_b - t_a = \Delta t$

$$200000.000004 \text{ s} - 200000 \text{ s} = 0.000004 \text{ s}$$

So this experiment, if done in the direction in which light travels at an infinite speed will give us

$$c_{AB} = \Delta t / d$$

So,

$$c_{AB} = 299792458 / 0.000004 = 7.49 \times 10^{13} \text{ m/s}$$

One can clearly see this is way greater than the value of c. And if we do the same experiment in the opposite direction the time difference would be

$$t_b - t_a = \Delta t$$

$$200002.000004 \text{ s} - 200000 \text{ s} = 2.000004 \text{ s}$$

Which would give us a speed of

$$c_{AB} = 299792458 / 2.000004 = 149895929.208 \text{ m/s}$$

This is quiet close to c/2 which is **149896229 m/s**. And only if light travelled at c, in both the directions, then we would get same value for both the directions. So this experiment can be used successfully to find out if light propagates with same speed in different directions.

#### ACKNOWLEDGMENT

This paper is inspired by a YouTube video posted on Derek Muller's<sup>1</sup> channel, Veritasium<sup>2</sup> called 'Why No One Has Measured The Speed Of Light'<sup>3</sup>.

#### References

- [1]: [https://en.wikipedia.org/wiki/Derek\\_Muller](https://en.wikipedia.org/wiki/Derek_Muller)
- [2]: <https://www.youtube.com/c/veritasium>
- [3]: <https://youtu.be/pTn6Ewhb27k>